PREDESIGN LETTER REPORT

PREPARED BY: Gordon Culp, Smith Culp Consulting

TITLE: CSO experience at other facilities

DATE: November 26, 1997

Michigan Projects

The current "hot bed" of activity in testing and demonstrating various methods of treatment and storage of CSO is in Michigan in the Rouge River (Detroit area) Basin of Michigan. The Rouge River Program has received several hundred millions of dollars in Federal grants to demonstrate CSO treatment methods and several large projects have been or are being built. Although not all are yet in operation, their design data are of interest. All use sodium hypochlorite for disinfection and are designed for a dosage of 10 mg/L. They are all required to discharge no more than 1 mg/L chlorine residual and all have a goal of fecal coliform of no more than 400/100ml. They are generally designed for a 1 year, 1 hour storm although two (Dearborn Tunnel and Dearborn Heights) are designed for a 10 year, 1 hour storm. The major design features are summarized below. The estimated dates of completion are shown in the facility column.

Facility	Peak flow (mgd)	Description	Max Overflow rate	Cleaning
Redford (in operation as of 6/97)	123	1.5" screen, 35' dia. Swirl, 2 rect. basins 180'x66'x11.2'	5180 gpd/sq. ft.	Tipping buckets, 2% slope, 100 gals./tip/ft. of wall
Inkster (in operation as of 6/97)	147	1.5" screen, 2 rect. Basins, 186'x60'x11.75'	6600 gpd/sq.ft.	Tipping buckets, 2% slope, 100 gals./tip/ft. of wall
Acacia Park (in operation as of 8/97)	212	2 rect. Basins , 160'x80'x20', ¾" effluent screens	7500 gpd/sq. ft.	Flushing troughs using industrial water
Bloomfield Village (in operation as of 10/97)	494	3 rect. Basins, 157.7'x128.5'x20'effluent screens	6760 gpd/sq.ft.	Flushing troughs using industrial water
Dearborn Heights (in operation as of 10/97)	131	1.5" screen, 3 rect. Basins, 175"x60'x11.6'	4200 gpd/sq.ft.	Tipping buckets, 2% slope, 100 gals./tip/ft. of wall
Birmingham (1/98)	310	2 rect. Basins, 140'x120'x20', ¾" effluent screens	7856 gpd/sq.ft.	Flushing troughs using industrial water
Hubbell Southfield (12/98)	775	1.5" screen, 2 rect. Basins, 900'x240'x16.5'	4000 gpd/sq.ft.	Flushing nozzles, 20 flushing areas per tank, 5000 gpm/flushing area
Puritan/Fenkell	426	½" screen, 2 rect.	9,979 gpd/sq.ft.	Tipping buckets, 7

(7/97)		Basins, 236'x99.5'x8'		flushing tanks per basin, hose bibbs for added washing
Seven Mile (11/97)	103	½" screen, 2 rect. Basins, 200'x91.5'x8'	2800 gpd/sq.ft.	Tipping buckets, 6 flushing tanks per basin, hose bibbs for added washing
Dearborn Tunnel	30 min. detention of 10 yr, 1 hr storm; complete retention of 1 yr, 1 hr storm	Bar screens, 18' dia. Tunnel x 11,400', 50'dia. X 190' deep sed chamber at end of tunnel		Min velocity of 3 fps, water stored for flushing, flushing gate opens 1'/minute

The Dearborn Tunnel project was originally planned to be a deep tunnel in rock. Groundwater investigations have caused the original design concept to be scrapped and the tunnel is being redesigned at a higher elevation in soft soils.

Data are being collected to evaluate the treatment effectiveness of the different basins as they go into service. For those basins in service, no evaluation of efficiency data is yet available. The first release of operating data is expected in January, 1998 and will be published in the WERF publication *Wet Weather RX*.

In addition to the above projects, Wayne County has four other CSO tanks that have been in service for several years ranging in volume from 2 million gallons to 19 million gallons. The projects all involve pumping into the CSO facilities and gravity flow out. Wayne County has been using vertical turbine pumps for CSO for 20 years in some cases with very good results. They are very pleased with Cascade vertical turbine pumps for this application. The pumps are preceded by mechanically cleaned screens with opening ½ the size of the solids that can be passed by the pump. They use stainless steel impellers which are easier to repair than cast impellers.

The O&M staff likes the sequential filling procedure because it minimizes cleaning in small storms. They wished that they had some smaller pumps for handling smaller storms. Their pumps are sized for the design storm and do not operate efficiently in the smaller storms.

Chlorine of the intermittent and highly variable flows has been a challenge. They are attempting to meet their chlorine residual discharge limit by controlling the chlorine dose rather than dechlorinating. Their fecal coliform removals have been variable. They have fed up to 20 mg/L of chlorine in the first basin within a CSO storage basin.

Reportedly, the tipping bucket method of cleaning has proven satisfactory so long as the basin length is not excessive in proportion to the number of buckets. The O&M staff prefers the tipping buckets to spray systems. They feel the buckets do a better job of cleaning and use less water to do it. For small storms, they sometimes have to flush the basin twice. Although the flushing gate concept is not yet in operation in the Michigan facilities, it has worked well in Canada and Europe. Water is retained in a chamber at the inlet end of the basin behind a wall of about five foot height in a 20 foot deep tank. When the rest of the tank has drained, a gate in the wall opens and releases the water to flush out remaining sediments.

All of the CSO facilities are covered with the surface used for basketball courts, soccer fields, golf courses or walk through parks. They have wet scrubbers for odor control but have not found it necessary to run the systems. They operate the fans on the basins only about 10 minutes per month.

They have not had corrosion problems in their older basins. They use titanium coated metals and a lot of plastic materials on interior of their basins to avoid corrosion problems.
Should King County and/or HDR staff want to tour the above facilities, contacts to arrange such a tour are: Rouge River Program Office: Vyto Kaunelis (313-224-3632) , Kelly Cave (313-961-0700), or Jim Murray, Executive Director; and Gary Fujita, the Detroit Water and Sewerage Department (313-224-4752).

Other Projects In Planning, Construction or Start-Up

Columbus, Georgia has constructed a CSO treatment facility that consists of coarse screens, 6-32 foot diameter vortex separators with ability to achieve dissolved air flotation and chemical coagulation within the vortex units, high-rate compressed media filtration, medium pressure ultra-violet disinfection and chlorination-dechlorination. The basins can be operated as flow-through or fill and treat units. A two-year testing program began in July, 1996. Chemical disinfection effectiveness is reportedly limited by the wide variations in chemical demand during a storm event.

Cincinnati, Ohio is constructing a 43 foot diameter Fluid Sep vortex separator preceded by a first flush tank.

The Northeast Ohio Regional Sewer District is designing a 20 foot diameter storage/conveyance tunnel for the Mill Creek Watershed.

New York City is constructing an underground 400 mgd vortex separator facility at Corona Avenue with three parallel types of units: USEPA swirl, German Fluid Sep, and UK Storm King. They are also constructing a 28.5 million gallon underground storage/treatment facility at Flushing Meadow/Corona Park scheduled to be in operation in 2001. The facility consists of 2 trains of 7 sequentially-filled basins in each train. The maximum throughput will be 1,400 mgd. Two cleaning systems are being tested: tipping buckets and hydroself. Wet scrubbers are being provided for odor control.

One of the difficulties is that many CSO treatment facilities, as is the case in the above Michigan and other projects, are only now being built or placed in operation. So, I have summarized experiences at some facilities that have been in operation for a significant period of time in the following paragraphs.

Sacramento, California

The City of Sacramento sends its dry weather flow to a regional wastewater plant. When flows exceed 60 mgd, the excess flows are sent to the City's former primary treatment plant that now serves as a CSO treatment facility. The CSO treatment facility provides primary treatment, chlorination (sodium hypochlorite) and dechlorination (sodium bisulfite) of 130 mgd. The CSO treatment plant has 3 full time staff that maintain the rectangular, mechanically cleaned clarifiers and disinfection system. During storms, two more staff assist in operation and perform the required sampling of the Sacramento River during the storm. Flows enter the CSO treatment plant about 22 times per year with overflows from the plant occurring about 10 times per year. Sludge and scum from the CSO plant is transferred to the regional plant during the storm. The tanks are drained to the regional plant after each storm and are cleaned using the scrapers in the tanks. The tanks are uncovered. In the summer, the tanks are thoroughly cleaned using a crew of five. The flights are propped up on blocks so sediment can be flushed underneath them. Two people are in the tanks with hoses flushing sediment toward the inlet end, two are on top of the tanks with hoses that keep the sediment moving, and one operates the sludge pumps.

When flows exceed 130 mgd, the excess flows are pumped to a 23 million gallon, 3.5 acre CSO storage facility, Pioneer Reservoir, which has been in operation for 20 years. A 10 foot diameter, 8,800 foot long interceptor feeding Pioneer Reservoir provides another 5 million gallons of storage. After the storm subsides, flows are returned by gravity through the same interceptor to the regional plant.

Two pumping stations that transfer flow to Pioneer Reservoir have capacities of 130 mgd and 530 mgd. The larger of the pumping stations is being upgraded to 740 mgd capacity. And 8000 kw of standby engine-generator capacity is being installed. Manually cleaned screens have been used in the pumping stations but are being replaced by mechanically cleaned climber screens. Keeping the manually cleaned screens free of debris has been very labor intensive, especially during the first flush. As many as five staff have been needed to keep the screens clean at the larger of the two pumping stations. When overflowing, the Reservoir has a hydraulic limitation of 350 mgd. At an overflow rate of 1500 gpd/sq.ft. (the design rate for the City's CSO treatment plant), the total area of Pioneer Reservoir equates to a 237 mgd capacity.

Pioneer Reservoir has three basins that are normally operated in series. The basins can be operated in parallel to reduce the headloss through the basins and allow higher flows to be pumped through them. During smaller storms and with the normal sequential operation, only the first or first and second basins are filled, reducing cleaning requirements. The City has found that

80-90% of the sediment is trapped in the first basin. A grit trap exists in the inlet structure and was recently cleaned with a bobcat and trip bucket. The concept was that the grit basin would be scoured by water returning from the Reservoir through the influent pipeline after the storm subsides but manual cleaning has been required.

The City has analyzed the treatment provided by the Reservoir when overflowing for 88 storms from January, 1992 through January, 1997. On the average, Pioneer Reservoir reduced the influent suspended solids from 103 mg/L to 53 mg/L (42% removal) and settleable solids from 1.8 ml/L to 0.1 ml/L (86% removal). There are significant variations in performance from storm to storm. On a total annual mass basis, the removal of suspended solids approached 50%. The overflow rate in the Reservoir averaged 1100 gpd/sq. ft. with a peak rate of 3260 gpd/sq.ft. The treatment performance of the storage reservoir is similar to the combined wastewater treatment plant. By adding chlorination (sodium hypochlorite) and dechlorination (sodium bisulfite), the State will accept the Reservoir as a primary treatment device. The City is currently installing the disinfection system and expects to place it in operation in February, 1998. Hypochlorite will be injected at the inlet and outlet of each section of the Reservoir. Bisulfite will be injected into the outfall to the Sacramento River.

The Reservoir was first equipped with fixed jets for washdown after a storm. One set of fixed jets was designed to flush the walls and a second set of jets was designed to flush the floors. The fixed jets did not perform well and have been replaced with water cannons which work well. The City feels that the walls have stayed clean without the use of the wall jets. Water is pumped from the adjacent Sacramento River for wash water.

The City has recently constructed an additional CSO storage tank (42^{nd} Street project). The tank has 1.4 million gallon capacity and was constructed at a cost of about $4,000,000 which includes about $400,000 for utility relocation. The rectangular (38 ft x 450 ft x 22ft deep) tank is located beneath a street in a residential neighborhood. The tank has a longitudinal wall that divides the tank into two sections that fill sequentially. After the storm subsides, the tank contents are pumped into the interceptor system by two submersible pumps located in a sump at the inlet end of the tank. The tank is cleaned using Vactor trucks. A manhole at mid-length and one at the outlet end provide access for the Vactor truck suction. There are no internal spray nozzles in the tank. The City had hoped to clean the tank with Vactor access only from the outlet end. It has proven necessary to access the tank at midpoint as well. The lack of level ground around the midpoint manhole has caused problems with Vactor access. Once per year the City staff uses high pressure hoses to flush the tank to the inlet end for a thorough cleaning.

The CSO storage facilities are unstaffed. Activated carbon is used for odor control. The odor control system at the 42^{nd} Street tank is operated a few hours each day and can provide up to 12 air changes per hour for the storage tank. Up to 4400 cfm can pass through the carbon system. A carbon system bypass has a capacity of 7680 cfm. The odor control system at Pioneer Reservoir is operated continuously. The carbon is housed in truck trailers that are hauled in and out as the carbon becomes spent. Galvanized metal within Pioneer Reservoir has held up well for 20 years. This fact is attributed by the City to the movement of air through the basins.

Saginaw, Michigan

The City provides primary treatment of CSO in a 3.6 million gallon tank (1500 gpd/sq.ft. overflow rate) that was placed in service in late 1970s. Hypochlorite is used to prechlorinate ahead of the settling tank. No screens or grit removal is provided. The only treatment requirement has been a fecal coliform of 200/100 ml, which requires 7-8 mg/L of prechlorination. The plant discharges to the Saginaw River. The facility is located in a downtown area and is completely enclosed under a parking facility. The pump stations crews check the facility and there are no on-site operators. After a storm subsides, the tank contents drain back into the sewer system. A crew of 2 spends about ½ day cleaning up the basin by using hoses and in-basin flushing nozzles. Carbon scrubbers were provided for odor control but proved ineffective and are no longer in use. They have found that prompt flushing minimizes odors.

New York City

New York has operated the Spring Creek CSO facility (six parallel basins, each 376 feet long by 50 feet wide) since the mid-1970's. It is New York City's only CSO facility. Although flow enters the units about 100 times per year, they fill to the point of overflow only about 10-15 times per year. The plant discharges to tidal waters and the stored water goes to the 26th Ward plant for treatment. No screening is provided ahead of the units. They recommend avoiding screening prior to settling because large debris can be removed at leisure from the settling basins but would require immediate attention if retained on a screen. Automated operation was planned but maintenance problems resulted in full-time staffing by six personnel. They have had difficulty pacing the chlorine feed. Sludge is removed by travelling bridges with sprays that wash out retained solids. They have had corrosion problems with the spray system.

San Francisco

Flows in excess of the main plant capacity are stored in large, upstream storage facilities. When the storage fills, flow goes to an old (1951) primary plant which is now used only for CSO treatment. The storage overflows to the treatment plant about 26 times per year. The primary plant has a capacity of 150-180 mgd and was converted to CSO treatment in 1981-82. The plant has treated CSO at overflow rates of 3000 gpd/sq.ft. and produces TSS of 40-60 mg/L, about 100 mg/L BOD. The plant discharges about 4.5 miles offshore in 80 feet of water. During the rainy season, the plant is staffed with 1-2 people around the clock. In the dry season, there is daytime maintenance only. They have found that the upstream storage is self-cleaning in regard to rags and sand. It is sloped at 2 feet/1000 feet. They have had no significant problems with the facility.

Johnson County, Kansas

The county has four CSO treatment plants, all located underground, ranging in capacity from 8 to 20 mgd. Three of the plants use rectangular basins and one uses a circular basin. They were placed in operation about 1970. Grit, rags and solids are all returned to the collection system because they do not want to haul them through the residential neighborhoods where these facilities are located. The basins operate at about 2500 gpd/sq.ft. and are about 7 feet deep. The plants discharge to intermittent streams. The plants are checked once per day with about 15 minutes spent per visit to see if any water has entered the plants and to check the hypochlorite systems. When the plants are in operation, pump and scraper operation is monitored. After each use, the basins are hosed down by maintenance crews to remove debris not collected by the scrapers. They had some problems with rags and had to enlarge the lines which return sludge from the basins to the sewers.

Decatur, Illinois

The plant, a vortex separator, was placed in service in 1987. A mechanically cleaned screen and a holding tank for the first flush which is aerated precede the vortex separator. Two-three people spend about ½ day hosing down the units with 100 psi fire hoses. They have achieved about 20% BOD removal but removal is erratic near the design rate. I spoke with the designer and he states that the facility has performed well over the last 10 years. They have received more grit at the facility than anticipated. They return the grit to the interceptor. Next time, he said he would classify and dispose of the grit at the CSO facility rather than reinject into the interceptor. There have been no odor problems.